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1 Introduction

The transnational research programme **"Call 2014: Asset Management and Maintenance"** was launched by the Conference of European Directors of Roads (CEDR). CEDR is an organisation which brings together the road directors of 25 European countries. The aim of CEDR is to contribute to the development of road engineering as part of an integrated transport system under the social, economic and environmental aspects of sustainability and to promote co-operation between the National Road Administrations (NRA).

The participating NRAs in this Call are Belgium-Flanders, Finland, Germany, Ireland, Norway, the Netherlands, Sweden, United Kingdom and Austria. As in previous collaborative research programmes, the participating members have established a Programme Executive Board (PEB) made up of experts in the topics to be covered. The research budget is jointly provided by the NRAs who provide participants to the PEB as listed above.

BEST4ROAD is a two years project aiming at the development of best practice guidelines and tools for the efficient procurement of road maintenance in a changing world. Based on a comprehensive and integrative framework for maintenance procurement, the project will bring together the extensive, yet scattered procurement knowledge and experiences at National Road Authorities (NRAs) in 9 countries including the US and Australia. It will determine the lessons learnt at the NRAs and based on that will develop a number of hands-on tools and step-by-step guidance for procuring road maintenance taking current and future challenges of NRAs into account.

The benefit of the BEST4ROAD project for NRAs lies in the integration of an in-depth study and comparison of maintenance procurement practices in different countries with the development of tools and guidelines that can be easily implemented and used at NRAs. This will allow NRAs to learn from their peers and at the same time improve their maintenance procurement practices to get prepared for future challenges such as staff turnover and shrinking budgets.

The BEST4ROAD project consists of seven work packages (WP):

WP1 – Comparison of maintenance procurement practices

WP2 – Maintenance procurement strategies and maintenance efficiency

WP3 – Quick scan method for risk in maintenance procurement

WP4 – Competence profiles and transition processes

WP5 – Best practice guidelines

WP6 – Dissemination and demonstration

WP7 – Project management

The main objective of WP1 is to study, scan and compare maintenance procurement practices in 9 countries and identify commonalities and differences in terms of driving factors for maintenance procurement practices, effects of maintenance procurement practices on road quality and maintenance costs, and risks experienced with current maintenance procurement practices and how they are managed.

This report presents a framework for procurement practices in road maintenance.

2 Framework overview

The main focus of the BEST4ROAD project is maintenance procurement that is defined as all activities and decisions necessary for a NRA to acquire maintenance services for road infrastructure from supplying contractors. Maintenance procurement goes beyond the sole purchasing function of an organization and covers the entire process from the identification of maintenance requirements to the management of maintenance contracts.

Maintenance as the procurement object involves all activities during the life cycle of road infrastructure assets intended to retain the assets in, or bring them to, a state in which they can perform the required function considered necessary to deliver a defined service. Since this may include a possible change of the required functional performance or the function itself during the life of an asset, the understanding of maintenance in the BEST4ROAD project is not restricted to activities preserving road performance but also involves performance upgrades of road infrastructure. Moreover, maintenance is understood as a cyclical process where the actual operational work is preceded by supporting management activities such as inspecting, monitoring and predicting of road performance and, based on that, developing maintenance strategies and planning maintenance work.

In order to study and compare maintenance procurement across different countries, a comprehensive framework is required describing how maintenance activities are procured, what the drivers are for procurement practices, and what the consequences are of these practices. BEST4ROAD project uses a framework based on PIARC (2003), Mattsson and Lind (2009) and Hartmann et al. (2014) (Figure 1).

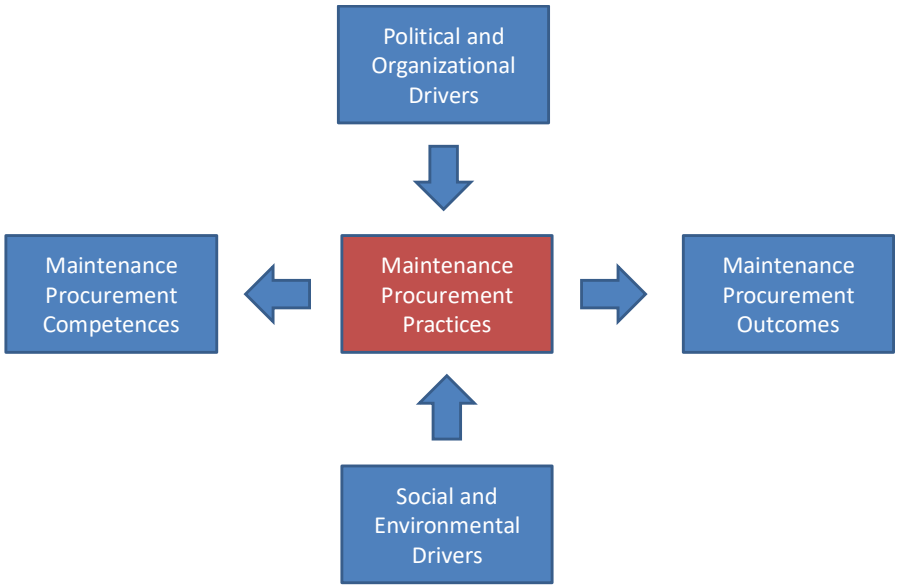

Figure 1. Maintenance procurement framework

The framework consists of the following procurement components and aspects:

Maintenance procurement context: relates to the drivers that can explain the development towards certain maintenance procurement practices and the appropriateness of these practices for achieving intended maintenance outcomes. The context of NRAs includes political, organisational, social and environmental factors.

Maintenance procurement practice: relates to past, current and future approaches of NRAs in different countries in terms of procuring road maintenance. Aspects of procurement practices are: the maintenance contract design (e.g. geographical scope, kind and number of assets integrated, contract duration, performance specifications), the maintenance tender procedure (e.g. evaluation criteria, evaluation process), and the maintenance contract management (e.g. quality management, performance measurement).

Maintenance procurement outcomes: relates to the consequences of maintenance procurement practices for the effectiveness and efficiency of road maintenance. Indicators for the maintenance effectiveness are for example road quality (e.g. condition index) and the user satisfaction or achieved level-of-service. Maintenance and user costs (e.g. cost/km of maintenance, administrative costs as percentage of total budget, changes in user cost components) give an indication for the maintenance efficiency.

Maintenance procurement competences: relates to the required skills and capabilities at NRAs to procure road maintenance. Contractual competences include an understanding of the implication of contract design on incentives for and risk attitude of the contractor. Relational competences include the ability to corporately find solutions for unforeseen events and conflictual situations. Technical competences include an understanding of the function and performance-related behaviour of road assets.

3 Maintenance procurement context

NRAs are public actors responsible for the maintenance of road infrastructure assets. Maintenance costs comprise both short- and long-term investments which are difficult to justify when allocating limited public funding. The procurement strategy of a NRA is a key factor in optimising the value for money achieved by infrastructure investments, since it will affect the performance delivered throughout the asset life-cycle. In order to decide on a procurement approach, NRAs need not only to understand different procurement options; they also need to understand under which circumstances which option is expected to be most effective (i.e. meeting the objectives of a NRA). This also includes a careful evaluation of which maintenance services and tasks should be outsourced at all. There are a couple of context factors that will drive procurement practices at NRAs and are expected to determine their effectiveness.

3.1 Political and organisational factors

Typically, NRAs are the executive arms of national governments and ministries and as such are embedded in a political environment where outsourcing of maintenance activities is a response to an increased inability of the state to finance the delivery of public services and a promise for more value for money (Grimshaw et al., 2002). Politically-imposed resource reductions (e.g. maintenance budget, employees) and end-user orientation has forced NRAs to buy road maintenance services from private suppliers. The intended overall goal is to improve road quality while spending less money. While achieving cost saving was one of the main driver behind road maintenance outsourcing, it has been replaced by the value-for-money argument that not only assumes efficiency gains through the private sector involvement but also the stimulation of innovation, the increase in flexibility, and the access to specialised knowledge (Segal et al., 2003). However, outsourcing maintenance services is a strategic decision that should be based on a proper business evaluation rather than politically motivated reasons. Instead of being urged by political agendas to rapidly change and implement procurement approaches, NRAs should invest more time in learning from ongoing and previous practices (Hartmann et al., 2014).

It is important to note that each NRA has its own organisational history, structure and working culture. Whether and how a new procurement strategy should be implemented depends on a number of organizational factors such as the available technical and managerial knowledge and skills, the existence of careful asset inventories, sound history and trend data on asset conditions and maintenance cost. Although the introduction of new procurement practices is the attempt of many NRAs to increase the effectiveness and efficiency of their service delivery, new practices themselves often represent disturbances of the current way of providing road maintenance and cause contradictions with the historically and socially developed structure of the maintenance management system. New procurement practices try to rearrange the way road maintenance is carried out, but interfere with the familiar behaviours, understandings and roles of public and private parties. Contradictions can relate to different interpretations about the feasibility of the procurement practice itself. New procurement elements (e.g. functional specification) can entail situational and behavioural limitations which contradict initial expectations. Contradictions already existing under previous maintenance regimes can be aggravated and their occurrence can be reinforced. Such contradictions often relate to the relationship of public and private organizations and the internalized mistrust between the different parties. However, with new maintenance procurement employees need to unlearn capabilities, competencies and behaviour acquired and cultivated throughout the years. Here also lies one of the major shortcomings of many NRAs when implementing new procurement practices for road maintenance. The effects of different maintenance contracts on working

procedures, competencies of employees and relational behaviour of contract partners are insufficiently taken into consideration. Forced to quickly present a changed situation, the dynamic and complex character of the procurement change is often neglected. That also means that much effort is employed to find adequate answers to problems in the management processes, but less effort is spent to find ways how these answers could become part of the operational practice. The entire process from the first application in a pilot project until the wider use within the organization is hardly addressed (Hartmann and Dewulf, 2009). The adjustment of contracts to the peculiarities of the network can be one reason why changed practices require additional effort and resources. Another reason can be that often only through the application of a contract can its performance be observed and compared with the expected outcomes. The target/actual comparison forms the basis for further improvements. As mentioned above, what is often neglected is the fact that the change process does not stop with a new concept or a first successful test in a pilot project. Implementation and consolidation of new practices are also connected with conflicts and problems emerging from contradictions with the existing social, legal and technical environment of which the new idea becomes part. Additional effort and resources are needed to meet these problems and to integrate the new procurement practice into its surroundings.

3.2 Social and environmental factors

Road infrastructure is exposed to a changing social and environmental context. On the one hand, innovative energy and data technologies will change the way transport infrastructure is used and its performance is monitored and evaluated. For example, new generations of sensors and actuators enable more cost-effective maintenance and operation strategies, such as remotely-operated and monitored bridges and moving from fixed to targeted maintenance approaches. On the other hand, the demand on road infrastructure has steadily increased and reached a level where aged assets are no longer capable to bear traffic loads. There a several examples of road bridges throughout European countries that had to be closed for heavy traffic due to structural capacity problems. In addition, climate change effects represent serious vulnerability threats for road infrastructure. Increased precipitation and periods of extreme temperature changes are among those climate events that are expected to have and already have a considerable impact on the operation of road infrastructure networks. For example, landslides and flooding of roads as results of extreme rainfall decrease the safety and comfort of road users, lead to road closures and thus longer travel times and the inaccessibility of entire regions.

For NRAs it becomes vital to plan, prepare and take actions in due time, in order to anticipate these future developments. However, the decision to invest in more advanced and resilient road infrastructure is a trade-off between the expected (future) benefits of interventions and the associated costs for implementing these interventions. Here, the role of procurement is of increasing importance, since it typically allows NRAs to maximize the value of construction and maintenance investments. Incorporating future developments into procurement practices is thus an essential step towards more advanced and resilient road infrastructure, but at the same time represents a challenging task due to the long-term uncertainties related to expected social and environmental changes. There are different ways of considering future developments in maintenance procurement ranging from environmental performance indicators, cost-benefit analysis, warranties and risk allocations to incentives schemes for innovative solutions, the implementation of “no regret” measures and the application of real options techniques. However, finding effective ways requires not only an overall established decision-making process but also different skill sets of NRAs and contracting parties (Camcray et al., 2009).

4 Maintenance procurement practices

Maintenance procurement practices describe the approaches used by NRAs to procure road maintenance. Although there are no standardised approaches and each NRA may adopt different procurement strategies and processes, a common element in every procurement practice is the contract. The contract determines in a legally-enforceable way the tasks and responsibilities of the maintenance contractor and the requirements of a NRA in terms of the services to be delivered and the service delivery process. In order to allow the comparison of practices between NRAs, three main, contract-related components of maintenance procurement are distinguished: contract design, contract tendering, and contract management.

4.1 Contract design

The design of maintenance contracts will have a major impact on the effectiveness and efficiency of maintenance service provision. In the following main contract design aspects are outlined.

4.1.1 Type of maintenance tasks

A maintenance contract can cover different types of maintenance tasks generally categorized into *operational and management tasks*.

Through operational tasks the actual physical maintenance work is carried out (doing maintenance). They are often divided into regular maintenance and rehabilitation. *Regular maintenance* (also periodic or routine maintenance) involves all activities that are of a repetitive nature and are executed in short-term intervals (<1year). However, this does not mean that their amount is predictable. The activities are often small in terms of resource demand and aim at retaining the condition of road assets rather than bringing them to an increased performance level. Typical regular maintenance activities include cutting grass, cleaning drainages, and small pavement repairs.

Winter maintenance and emergency repairs will be also classified as regular maintenance. Winter maintenance involves activities like snow ploughing and road salting and can form a larger part of an NRA's maintenance tasks depending on the climatological region. Emergency repairs can include pothole patching, lighting repair or flushing of blocked drainage systems.

Rehabilitation (also variable maintenance), on the other hand, is carried out in longer, non-repetitive intervals (>1year), involves a larger amount of work, and aims at enhancing the service life of a road asset or improving its performance. It is often based on a long-term planning taking the deterioration behaviour of the assets into account. Typical rehabilitation activities include pavement resurfacing and bridge joint replacing.

Operational tasks are supported by management tasks that can be also outsourced and bought in from private suppliers (e.g. consultancy firms). These tasks relate to the broader asset management practices of a NRA and involve all activities that trade-off costs, opportunities and risks against the desired performance of road assets, to reduce the expenditures over the life-cycle of the assets while extending the period for which the assets provide their required performance (ISO, 2014).

Main asset management tasks are the *monitoring* of road infrastructure and the *planning* of interventions. Monitoring includes the inspection of road assets, the registration of inspection results, the modelling of deterioration behaviour and the preparation of the information needed

to decide on asset conditions and risks and the quality of work to be performed. Planning includes the development of maintenance strategies, the programming of rehabilitation projects, the formulations of specifications for asset-related interventions, and the maintenance work planning.

4.1.2 Type and number of assets

A maintenance contract can cover different types and numbers of road assets. Road assets can be categorized as built and installed assets:

Built assets typically include:

- Roadways, including pavements, hard shoulders, lay-bys, kerbs, road studs and road markings;
- Road drainage, including channels, interceptors, manholes, piped drainage, ditches, balancing ponds;
- Geotechnical structures, including embankments, cuttings, retaining walls, reinforced earth, anchored walls;
- Bridges, including fixed/moveable bridges, footbridges, animal bridges;
- Tunnels, including rock/soil/underwater tunnels, pedestrian underpasses, culverts;
- Landscaping, including verges, grassed areas, hedges, shrubs, woodland, trees, scrub, wetland.

Installed assets typically include:

- Road equipment, including traffic signs, signals, guardrails, lighting, fences;
- Communication equipment, including traffic control devices, telematics systems, communication cabinets, emergency telephone boxes, CCTV, speed cameras.

Maintenance can be contracted for a single asset (e.g. tunnel), multiple assets of the same type (e.g. bridges), and multiple assets of different types (all assets within a road corridor) (Hyman, 2009). Single asset contracts might be used in cases of complex engineering structures such as tunnels and bridges that consume a larger amount of maintenance resources and/or require specific technical knowledge. Less complex assets of the same type (e.g. traffic signs) can be combined in one contract to achieve some economies of scale. The same holds for contracts including multiple assets of different types. Here, in addition, the coordination of maintenance activities of co-located assets can be improved. Placing the responsibility for entire road assets or asset groups on a single contractor may help avoiding situations in which the responsibility for asset failures cannot be clearly allocated due to several different contractors working on assets.

4.1.3 Performance specifications

Maintenance contracts specify the performance a contractor has to deliver. Performance specifications can relate to the maintenance tasks carried out, the maintained road assets, and the services provided by the road assets.

Task-related performance specifications (also called method-based specifications) determine maintenance input (what should be used), process (how it should be done) and/or output (how much and when should it be done). In other words, they detail the resources and activities that

a contractor needs to allocate and carry out for maintaining road infrastructure. For example, for winter maintenance the number of two-lane equivalent kilometres of road per snowplow could be specified (Otto et al, 1999). In case of pavement maintenance, the type of asphalt to be used and the road kilometres to be resurfaced can be described. These types of specifications allow a NRA to control how assets are maintained and when they are maintained, but at the downside require resources (staff, equipment) to continuously monitor the contractor's work (Garza and Arcella, 2013).

Asset-related performance specifications address the outcomes of a contractor's maintenance activities in terms of the infrastructure asset conditions the contractor needs to achieve. For winter maintenance, this might be the number of hours per month of less than good winter driving conditions for a geographic area (Otto et al, 1999). A performance specification for pavement maintenance could be the roughness index for asphalt (Pakkala, 2002). With these performance specifications, the maintenance contractor becomes more self-regulated in terms of frequency of maintenance tasks and resources to be deployed and the monitoring of whether the contractor achieved the required outcome can be reduced (Garza and Arcella, 2013).

Service-related performance specifications aim at the outcomes of maintenance activities that relate to the desired value creation impacts of road assets for users and other stakeholders. Such impacts may include the delays of scheduled bus services due to winter conditions or the satisfaction rating of road users in terms of riding comfort (Otto et al, 1999). With service-related performance specifications the freedom of the contractor to decide on kind and schedule of maintenance activities increases further. However, it should be noted that the service-related performance outcomes may also be influenced by factors (e.g. economic developments, land use patterns) that are beyond the direct control of the contractor (Baird and Stammer, 2000).

For the decision on which type of performance specification to use it is important to consider the interdependency of task-related, asset-related and service-related performance. Task-related performance specifications will have an impact on asset-related performance that in turn will have an impact on service-related performance. For example, specifying the type of asphalt to be used will have an influence on the rutting behaviour of the pavement and, consequently, on the riding comfort of the road user. For the reversed direction, this means that a desired service-related performance will require a certain asset-related performance to be achieved by a certain task-related performance (Baird and Stammer, 2000).

4.1.4 Payment mechanisms

Another design issue that will have an impact on the provision of maintenance activities is the payment mechanism. Typical payment mechanisms for maintenance contracts include unit price, lump sum and cost-plus fee (Menches et al., 2010).

The *unit price mechanism* is based on a list of unit items of maintenance activities priced at rate per unit and the actual quantities of maintenance units carried out. It can be particularly used when the scope of maintenance activities is known but the exact quantities are unknown or difficult to determine prior to tendering (Parkman, 1998; PIARC, 2003; Antoniou, 2013). However, the NRA takes the risk of any quantity variations and an incentive for the contractor lies in an increased amount of work.

With the *lump sum mechanisms,* the risk of quantity changes is, to a large extent, shifted to the contractor, since a fixed price is paid irrespective of the actual cost (Parkman, 1998; PIARC, 2003; Antoniou et al., 2013). On the other hand, it offers the contractor the incentive to obtain efficiency gains. However, any change in the scope of maintenance activities that is

contractually not traceable, may lead to disputes and higher extra costs for the NRA.

In case scope and quantity of maintenance activities are indefinite the *cost-plus fee mechanism* can be applied. The contractor is reimbursed for the costs incurred plus a fee for overhead and profit. The fee can be fixed and independent of the actual cost or can be a percentage fee (Antoniou et al., 2013).

Payment mechanisms are often combined with additional incentives that make the payment conditional upon the achievement of contractually-agreed performance goals (Alyami and Tighe, 2013). For example, by setting up target costs on a year-to-year basis for the cost-plus fee payment combined with pain/gain sharing for achieving the target an incentive is created for contractor efficiency. Another example is the combination of a lump sum payment with penalties/rewards to create an incentive for achieving a particular availability percentage of roads during a defined period (Pakkala, 2002).

4.1.5 Contract duration

Maintenance contracts can have different durations. They may last from less than one year to several years including some warranty period and should ideally cover the expected service life of road assets (Hardy, 2001). Increasing contract length may induce the maintenance contractor to make more specific investments, because an increased contract duration protects the contractor against holdup that depresses anticipated returns on investment. Moreover, long-term contracts may allow contractors to capitalize on potential economies of scale, stimulate learning by doing, and suffer comparatively less from anticompetitive bidding practices as competitors interact less frequently. On the other hand, an increased contract duration may partly eliminate market discipline and can suffer to the extent that contract renewal serves as a performance incentive. Finally, long-term contracts may reduce the flexibility of NRAs and increase the lock-in effect (Buiten and Hartmann, 2015).

4.1.6 Geographical scope

Road infrastructure possesses network character and, thus, is geographically spread. Consequently, maintenance contracts are always concluded for a geographically bounded area that corresponds in the case of maintaining single assets with the direct location of the asset. The geographical scope of a contract increases with the maintenance of multiple assets, because the assets typically reside at different locations within the road network or corridor (Pakkala, 2002). It often coincides with an administrative region and by clustering the maintenance in an administratively defined region a single point responsibility for specific maintenance activities and/or assets can be created. However, a match between geographical scope of a maintenance contract and administrative region does not necessarily lead to an optimal clustering, since administrative boundaries follow different rationalities. In addition, an increased geographical area can require more transportation and longer response time that can counteract economics of scale potentially realized with the bundling of assets and activities.

4.1.7 Contract volume

The contract volume can be seen as a mediating factor for deciding on other design aspects, since it typically increases with the number of maintenance activities, the number of assets, and the contract duration. An increased contract volume may eliminate market competition

due to a reduced number of contractors being able to make initial investments, bear involved risks, and provide the necessary capacity and expertise. In addition, with the contract volume the cost and time for tendering can increase (Pakkala, 2002).

4.1.8 Contract types

Although numerous maintenance contracts can be designed based on the described aspects, three generic contract types are distinguished that can be often found at NRAs:

Discrete contracts are typically used for planned maintenance activities with project character (e.g. rehabilitation activities). As such they are short-term contracts often based on lump sum payment and task and/or asset-related performance specifications.

Framework contracts are typically used for planned and unplanned maintenance activities that are carried out within a specified time period on a call-off basis. They can possess a medium to long-term duration and often make use of unit price payments.

Integrated contracts are typically used for planned maintenance activities that reoccur within a certain time period. They can integrate different activities (routine maintenance and/or rehabilitation) and different assets (built and/or installed assets), have rather a long-term duration, rely on lump sum payment and asset/service-related performance specifications.

4.2 Contract tendering

Another essential part of procurement practices in road maintenance is the contract tendering. From a public perspective, it should be set up as a transparent, generally understood and auditable process, in order to encourage a fair competition among the parties with interest in the maintenance tasks and the ability to carry out these tasks. However, depending on the procured maintenance volume the tender process can become bureaucratic and time consuming. Resources needed for the preparation of tenders can be very extensive inhibiting the participation of SMEs. Therefore, contract design considerations should precede any tender process. Typical aspects of contract tendering include:

4.2.1 Market consultation

Particularly for larger and more complex bundles of maintenance tasks that have not been contracted a market consultation before tendering can be beneficial. Market consultation can be seen as a two-way exchange of information and discussion between the NRA and the supply chain. Its aim is to communicate the unmet maintenance needs and requirements of the NRA to potential contractors and allow contractors to give feedback on whether and how they might be achieved. The state of the market, the ability of the market to respond to the maintenance needs, and the market conditions necessary to deliver the needs can be assessed. Through market consultation it can be revealed whether contractors are interested in delivering solutions that meet the maintenance requirements and whether they are technically and financially capable of doing so. It furthermore will show whether the tendering of the maintenance tasks will be sufficiently competitive, what possible barriers for contractors are, and how these barriers might be overcome. Based on the results of market consultation the NRA can revise and refine the maintenance package to be delivered and the tender process.

4.2.2 Prequalification

The tendering procedure may also include a prequalification stage that is meant to prevent contractors not suitable to deliver the required maintenance tasks from taking part in a tender. Prequalification can be part of the process for a specific tender but can be also used to build up a database with suitable contractors for a certain category of maintenance work (DHWP, 2003). In both cases tendering costs for NRA and contractor can be reduced. At the same time a certain level of competition can be remained. However, establishing and maintaining a prequalification system incurs costs and, thus, should be only used in case of complex and recurrent tasks. In addition, prequalification cannot eliminate contract failure; it can only reduce the failure risk (COOA, 2013). Potential contractors can be assessed against specific criteria such as (Holt et al., 1994):

- Experience: the contractor's experience in areas relevant to the required maintenance tasks
- Track record: the contractor's record of successfully delivering the required maintenance tasks
- Human resources: the competence and qualifications of the contractor's human resources
- Technical resources: the equipment and methods of the contractor to deliver the required maintenance tasks
- Financial resources: the contractor's ability to access the financial resources needed to deliver the required maintenance tasks.

In addition, assessment criteria may refer to previous maintenance tasks of the contractor and can include (Yasamis et al., 2002):

- Timeliness: Delivery of maintenance tasks within specified schedules (e.g. closed roads)
- Completeness: The amount of contractually-specified results delivered upon completion of maintenance tasks
- Courtesy: The degree of respect and kindness of contractor's employees
- Consistency: The ability of the contractor to repetitively provide the same results of maintenance tasks
- Accuracy: The ability of the contractor to provide contractually-specified results of maintenance tasks the first time with minimum amount of adjustments
- Responsiveness: The ability of the contractor to react to and report about unexpected events encountered during the contract (e.g. defects or incidents)

4.2.3 Tender evaluation

Submitted tenders can be evaluated in several ways by using different evaluation criteria. Typical evaluation criteria are price and quality of the maintenance tasks to be delivered and evaluation methods include (Bergman and Lundberg, 2013):

- price-only: based on minimum quality requirement levels the tender with the lowest price is selected;
- quality-to-price: a quality score is either subtracted from the price (if minimum quality

level is exceeded) or added to the price (if maximum quality level is not reached) and the tender with the quality-adjusted lowest price is selected;

- price-to-quality: price becomes one of the multiple quality scores that are weighted and combined to attain the overall bid score. The tender with the highest overall price-adjusted quality score is selected;
- quality-only: a base price per unit is set and the tender with the highest quality (overall score of weighted quality scores) per unit price is selected.

Price-quality tender evaluations (often called economically most advantageous tenders) can make use of different scoring rules that assign numerical or monetary values to different quality levels or that transform a value measured on one scale (price or quality) into a measure on another scale (price or quality), and finally aggregate quality and price scores into an overall score. The scoring rule should be carefully selected since it will influence the outcome of the tender evaluation.

4.2.4 Negotiation after bidding

Post-tender negotiation takes place after the formal receipt of tenders and before the formal award of contracts. It may be necessary if the tenders are significantly above budget or especially low on price. Post-tender negotiation may focus on the refinement of the original specification or the delivery period. This may lead to discussions around terms and conditions, warranties, payment terms or price. It should not lead, however, to significant revisions of specification or changed offers as this may alter competition and result in re-tendering.

4.2.5 Negotiation after expired contract

Although competitive tendering is the preferred option at many NRAs after expiring of a contract the recurrent nature of most maintenance tasks may also suggest negotiation with an incumbent contractor as an alternative approach particularly with an increase of maintenance complexity. A negotiation approach may prevent the risk of selecting a contractor that is intended to win a contract by submitting an unreasonable low bid and, after the contract is signed, to exploit any weaknesses in the contract documents to obtain higher prices. Another advantage of the negotiation approach are reductions in transaction costs due to less tenders and existing working relationships. However, in order to be effective, the negotiation should simulate the incentives involved in competitive tendering by, for example, having the possibility to revert to tendering if an agreement cannot be attained. A prerequisite for the negotiation approach is a good understanding of the minimum requirements to be fulfilled by the contractor. In this sense, competitive tendering should occur periodically to test the market and retain the interest of the market (Wallis et al., 2010).

4.3 Contract management

Once a maintenance contract is let it needs to be managed throughout its duration. Contract management mainly aims at ensuring the compliance of the maintenance contractor with the specified maintenance requirements and performance specifications and dealing with circumstances that are not clearly covered by contract documents. It involves the following activities:

4.3.1 Performance monitoring

Monitoring the performance of the maintenance contractor has the purpose of ensuring that the contractor is providing all maintenance tasks in accordance with the contract. It helps the NRA to become aware of and address any developing performance deviation and its underlying problems and as such also acts as a supporting tool for implementing the strategic goals of the NRA (Otto et al., 1999). Depending on what the NRA regards as important and what it specified in the contract the monitoring will focus on task-related, asset-related and/or service-related performance. In addition, the payment mechanism will have an effect on what needs to be monitored. For example, if payment is based on unit price mechanism, it is not necessary to verify the expenses of the contractor for transportation or administration. The NRA knows what is bought and the cost per unit item.

Monitoring itself can take place through reviews of the contractor's performance reports and site inspections to ensure the delivered work is in accordance with the contract requirements. The frequency of site inspections can vary from daily to monthly visits depending on contract and activity. The reporting is often done via comprehensive quality management systems that may include safety procedures, traffic control planning, emergency response planning, and maintenance work planning. Reporting techniques like report cards representing quantitative performance results with a grading scale or geographic information systems displaying performance information as maps can be used to make findings more accessible and comparable. By verifying actual performance against scheduled or reported performance the contractor is incentivised to dedicate sufficient and appropriate resources to maintenance activities (Ozbek et al., 2010).

For the case of detecting performance deviations the monitoring system should include defined follow up actions that aim at bringing the contractor back into compliance with the contract requirements. This is essential as the deviations will not correct themselves simply by identifying and reporting on them.

Monitoring results should also be used to improve the contract requirements for future contracts. This should also include a baseline inventory and performance assessment before a new contract is let to set target performance levels for the maintenance contractor (Ozbek and de la Garza, 2011).

4.3.2 Change management

Road maintenance takes place in a dynamic environment with uncertain future circumstances that are not contractually addressed. The longer the contract duration the greater the possibility that unforeseen maintenance-relevant events may occur. In these cases, it may become necessary to make changes to the contract, because scope of the maintenance work or terms of the contract are no longer in line with the altered situation. The original contract should set forth the conditions under which changes are dealt with. One way of dealing with changes can be mutually agreed amendments to the contract. They will be particularly required if the rights of contract parties are affected. Another way can be the right of the NRA to unilaterally modify the contract without the contractor's consent. In either case, before making any changes to the contract their maintenance performance and cost effects need to be evaluated. This may also include an evaluation of the extent to which the change is within the scope of what was tendered, because any substantial change in the scope of work may violate the requirement of fair competition in public procurement. Prior to their implementation all changes should be documented and approved, in order to avoid any accountability problems.

4.3.3 Dispute resolution

Related to the causes of contract changes (unforeseen events) are disputes that may occur if, for example, maintenance contractor and NRA have different perceptions of whether particular maintenance tasks are within or beyond the scope of the contract and whether or not justify additional compensation. The goal of any dispute resolution process is to address all diverging viewpoints and prevent the emergence of serious conflicts and their escalation to the next organisational level. Here, it is important for all involved parties to respond promptly to all inquiries and issues raised to avoid exacerbation of latent conflicts. Communication and negotiation are essential activities for solving disputes in an informal and economically efficient way. Hold-up behaviour, on the other hand, that tries to maximize gains at the expense of the other party will intensify existing conflictual situations and require more resource consuming resolution approaches such as arbitration and litigation (Mitropoulos and Howell, 2001; Cheung and Suen, 2002).

5 Maintenance procurement outcomes

Ideally, the choice of maintenance procurement practices is based on clearly formulated goals of a NRA that describe the expected outcomes if the practices are implemented. These goals often relate to an improvement of the current way of procuring maintenance tasks at a NRA. In order to identify best practices, the achieved improvements in maintenance procurement at NRAs need to be compared. Typical metrics to assess the improvement of road maintenance are: maintenance effectiveness and maintenance efficiency.

5.1 Maintenance effectiveness

Maintenance effectiveness describes the relationship between intended maintenance objectives and achieved maintenance outcomes. Road maintenance is effective if the intended maintenance objectives could be achieved. Procurement of road maintenance can be then regarded as one way of facilitating the attainment of maintenance objectives. Although maintenance objectives differ between NRAs, some generic objectives are: *road quality, level of service and user satisfaction*.

5.1.1 Road quality

Road quality refers to the required condition of road assets and its associated technical parameters. For example, a smooth surface might be a quality objective for pavements that may be translated into requirements such as no potholes or no distresses that are “X” cm higher or lower than surrounding pavement. Getting the expected quality from procured maintenance requires NRAs to specify either task-related performance (working method and material) or asset-related performance (asset condition output). Specifying task-related performance can be advantageous if the NRA knows what quality level can be achieved with which method and material. However, it does not provide any incentive for the contractor to use new methods or materials. By specifying asset-related performance a greater freedom for the contractor is created to propose the most effective method or material. A prerequisite is that road quality is described in measurable terms to prevent any misinterpretation of the NRA’s requirements.

5.1.2 Level of service

Level of service refers to the contribution of road infrastructure to society in the broadest sense. It recognizes that roads are only a means to an end and have a wider social, economic and environmental impact. They are meant to deliver a service to society or to create value for those who make use of them. The NRA can specify the service-related performance or level of service to be delivered by the contractor. For example, the level of service objectives may include an improved accessibility of a certain region or a reduced travel time for a highway link.

5.1.3 User satisfaction

User satisfaction can be seen as an ultimate objective of NRAs and corresponds to their understanding as service provider. Here it is important to note that user satisfaction relates to the perception of road users on the performance of road infrastructure. Although an increased road performance suggests a higher level of satisfaction, the relationship between expectation

and experience of road users will play a decisive role for the level of satisfaction. For example, high expectations in combination with a low experience often lead to a low level of satisfaction and the experiences of road improvements through maintenance can have a greater influence on satisfaction as the expectations about maintenance outcomes (Hartmann and Hietbrink, 2013).

Road quality, level of service and user satisfaction are connected objectives. For example, a smooth surface of the pavement will allow a certain travel speed and, thus, travel time that, if valued by road users, increases their level of satisfaction. In a general sense, the maintenance outcome is road infrastructure with specific condition parameters which performs services for road users. Road infrastructure is a resource that road users can make use of and integrate into their value-creation processes. Maintaining, upgrading or renewing road infrastructure facilitate the value creation of road users. The extent to which road users perceive value-in-use of road infrastructure then depends on their experience of the maintenance activities manifested in the experienced road condition parameters (Hartmann and Ling, 2016). From a procurement perspective NRAs need to decide on important maintenance objectives and their translation into task-, asset- or service-related performance requirements set out in the contract.

5.2 Maintenance efficiency

Maintenance efficiency covers the relationship between required maintenance resources and achieved maintenance outcomes. Road maintenance is efficient if desired maintenance outcomes can be attained with a minimum of resources. Procurement of road maintenance is then a means of reducing resources needed to attain specific maintenance outcomes. Resource reductions that are typically aimed for are: *cost savings and time savings*.

5.2.1 Cost savings

Cost savings in maintenance have always been an important objective for NRAs and there are many ways of achieving it, one of which is maintenance procurement. The decision of outsourcing maintenance activities to the private sector is mainly driven by cost savings aspects. While the lowest bid competition was the prevalent approach for realizing cost savings in previous years, a number of agencies have turned to a life-cycle cost perspective taking cost implications beyond the contract period into account.

5.2.2 Time savings

With the increased traffic intensity on road networks time savings have become another important efficiency objective. Maintenance often means temporal traffic disturbances and shortening the duration of maintenance activities will reduce the impact on road users. A related aspect is the response time for repairing road assets to prevent dangerous situations or traffic disruptions.

Maintenance effectiveness and efficiency are often brought together in an argument for maintenance outsourcing claiming that road quality can be retained even though money is saved. The belief behind this argument is that the private sector can organize maintenance activities more efficiently and, thus, can create value for money. However, although being very attractive and widely used, solid empirical evidence for the argument is hardly to obtain.

6 Maintenance procurement competences

Maintenance procurement competencies are important for National Road Agencies to work with internal and external stakeholders in achieving good value for money, and drive efficiency and effectiveness (Hartmann et al., 2010). With wider market and policy changes, procurement competencies – contractual, relational and technical skills and capabilities – are vital to ensure that agencies can deliver their asset maintenance tasks and activities (Hartmann et al., 2014). The move towards procuring more integrated solutions (bundles of products and services) linked to quite often complex performance outcomes (i.e. trouble-free use of assets) confronts buying organisations (i.e. NRAs) with the challenge of developing and implementing new procurement strategies (e.g. performance-based contracts) and build up and hone associated skills and capabilities (Essig et al., 2016; Roehrich and Caldwell, 2012). Different types of competencies, namely contractual, relational and technical, need to be in place in order to equip agencies with the right skillset and knowledge to perform productive activities and daily operational routines as well as possessing a strategic ability to integrate, build and reconfigure skills and knowledge to address changes in the wider market and policy environments. Competences are here defined as the ability of an organization to perform coordinated activities utilizing resources (internal and external to the NRA) to achieve a goal and to purposefully create, extend, or modify its resource base.

6.1 Contractual competences

Contractual competences include an understanding of the implication of contract design and management on incentives for and risk attitude of the contractor. In other words, contractual competences are vital in order to write, negotiate, evaluate, monitor, and enforce contracts (Mayer and Argyres, 2004). More specifically, contractual capabilities refer to the recognition of the contingencies associated with procuring maintenance tasks and activities and their (performance) implications for the efficiency and effectiveness of the maintenance service delivery (Hartmann et al., 2014).

Organisations can structure contracts and protect relationships with suppliers against opportunism by relying upon legal rules, standards and remedies implied in the law (Lyons and Mehta, 1997). As such, contracts are important planning and incentivisation tools particularly for long-term business relationships as they form the legally enforceable instrument and control mechanisms. However, in practice it is rarely possible or desirable to draft complete contracts owing to the complex nature of the task, asymmetric information and associated costs (Bijlsma-Frankema and Costa, 2005). In such situations, organisations deploy incomplete contracts with an element of uncertainty that makes them unenforceable in their entirety. Due to their inherent flexibility, these contracts are often better suited to deal with changes caused by environmental or endogenous contingencies. It is therefore up to the contracting parties involved to decide how much of the contract content and process specification should be pre-determined up-front or negotiated during the contractual period - relational competencies are vital in these situations to deal with changes and uncertainties.

6.2 Relational competences

Relational competences include the ability to corporately find solutions for unforeseen events and conflictual situations. Technical competences include an understanding of the function and performance-related behaviour of road assets.

Relational capabilities and competences are important to build inter-personal and inter-

organisational trust and foster learning within and across organisational boundaries (Hartmann et al., 2014). They refer to the application of socially complex routines, procedures and policies in relationships to drive problem-solving and information exchange (Johnson et al., 2004). Organisations need to invest in relationship-specific assets, exchange knowledge with each other, combine complementary and scarce resources and effectively govern relationships.

Contractual competencies are complemented by relational competencies to prevent conflicts and adversarial behaviour and to promote problem-solving and information exchange. Relational competencies are vital to effectively and efficiently procure maintenance services and deal with wider market and policy changes. Moreover, without appropriate relational competences, organisations would not be able to co-create value with their customers (working in a close relationship) when delivering and managing these.

6.3 Technical competences

In order to build up relational and contractual competencies, technical competencies related to the various assets and maintenance services are needed in order to, for instance, write tendering documents, evaluate bids, negotiate and monitor contracts. Please see a more complete list of assets, tasks and activities in section 4.1. These competences are also vital in engaging with an agency's customers and suppliers in strategic pre-bid activities, preparing proposals or managing strategic partnerships with customers and suppliers (Katzy and Crowston, 2008). Moreover, technical competences also help to manage the asset life-cycle including the procurement of relevant maintenance services.

6.4 Learning and transitions

In order to transition between different procurement strategies, learning to contract and build/maintain strong relationships with contractors is vital. Learning quite often starts with knowledge capture and transfer, as the competitive environments the NRAs are working in no longer involve stable incremental change but complex processes of discontinuous change (Hartmann et al., 2014; Roehrich and Lewis, 2014). A key goal for firms is to shift from an essentially static approach to learning, based on information acquisition, towards a greater emphasis on information interpretation and transfer (across levels). Capturing knowledge and ensuring a transfer and exchange of knowledge across internal (e.g. employees of the agency) and external (e.g. contractors) stakeholders (Barlow and Jashapara, 1998) is vital for agencies when seeking efficiency and effectiveness in procuring maintenance services.

Knowledge capture from internal and external stakeholders and transfer needs to be a deliberate cognitive effort and investment to improve an organisation's routines and activities. Contractual, relational and technical competency development is specifically supported by experiences gained when procuring road maintenance tasks and activities. For instance, agencies may learn how to monitor contracts with suppliers or how to build up collaborative relationships with contractors. However, agencies need to ensure capturing lessons learnt in an effective way through, for instance, workshops, databases, or best-practice guides. These lessons learnt need then to be transferred to key internal and external stakeholders to ensure that good/best practice is shared across the supply network, driving improvements in terms of efficiency and effectiveness. For instance, in order to co-create value (e.g. between an agency and its suppliers), partners need to pool their collective knowledge, develop a common understanding of their roles and responsibilities in the value creation process and engage in joint problem-solving.

7 Conclusions

The framework presented in this document provides a comprehensive set of issues to be considered when procuring road maintenance. It also lays down the main concepts and definitions used throughout the project. Particularly the differentiation between maintenance tasks can raise confusion and misunderstandings and requires a clear conceptional grounding. Of course, the definitions used in this project may differ from definitions used by the NRAs. However, it is believed that the framework covers all maintenance aspects that are relevant for the understanding of the maintenance procurement practices of NRAs and will allow their comparison. For the following deliverables of the project the terms and concepts defined here are used and when required it will be referred to this document.

8 References

Alyami, Z., & Tighe, S. (2013). Development of Maintenance and Rehabilitation Program: Pavement Assets Under Performance-Based Contracts. Transportation Research Record: Journal of the Transportation Research Board, (2361), 1-10.

Antoniou, F., Aretoulis, G. N., Konstantinidis, D. K., & Kalfakakou, G. P. (2013). An empirical study of researchers' and practitioners' views on compensating major highway project contractors. International Journal of Management and Decision Making, 12(4), 351-375.

Bergman, M. A., & Lundberg, S. (2013). Tender evaluation and supplier selection methods in public procurement. Journal of Purchasing and Supply Management, 19(2), 73-83.

Baird, M., & Stammer, R. (2000). Conceptual model to support systematic use of performance measures in state transportation agencies. Transportation Research Record: Journal of the Transportation Research Board, (1706), 64-72.

Barlow, J. & Jashapara, A. (1998). Organisational learning and inter-firm "partnering" in the UK construction industry. The Learning Organization, Volume 5 · Number 2 · 1998 · pp. 86–98

Bijlsma-Frankema, K. & Costa, A.C. (2005). Understanding the trust-control nexus. International Sociology, Vol. 20 No. 3, pp. 259-282.

Buiten, M. van, & Hartmann, A. (2015). An asset management perspective on public-private partnership contracts: A cost control trade-off? Journal of Construction Engineering and Management, 140(3), 04014080.

Camcray, A., Howcroft, A. Retana, J., Dowden, M., & Schellekens, G (2009). Adapting to climate change: the role of public procurement. Study carried out for the Greater London Authority, London, UK.

Cheung, S. O., & Suen, H. C. (2002). A multi-attribute utility model for dispute resolution strategy selection. Construction Management & Economics, 20(7), 557-568.

COOA (2013). Contractor prequalification: A best practice guideline of the Construction Owners Association of Alberta. Construction Owners Association of Alberta (COOA), Edmonton, Alberta, Canada.

DHWP (2003). Procurement guidance: Prequalifying suppliers. Procurement Transformation Division, Department of Housing and Public Works, Queensland Government, Brisbane, Australia.

Essig, M.; Glas, A.; Selviaridis, K. & Roehrich, J.K. (2016). Performance-based contracting in business markets. Industrial Marketing Management, Vol. 59, pp. 5-11.

Garza, J de la., & Arcella, J. (2013). Current Performance-Based Maintenance Methods to Improve Virginia Highways: Comparative Analysis. Transportation Research Record: Journal of the Transportation Research Board, (2361), 35-43.

Hardy, P. (2001). Austroads review of performance contracts: the potential benefits of performance contracts. Opus International Consultants, Nelson, 1-28.

Hartmann, A., Davies, A. & Frederiksen, L. (2010). Learning to deliver service-enhanced public infrastructure: balancing contractual and relational capabilities. Construction Management Economics, Vol. 28 No. 11, pp. 1165-1175.

Hartmann, A. & Dewulf, G. (2009). Contradictions in infrastructure management – the introduction of performance-based contracts at the Dutch Highways and Waterways Agency. Proceedings of the International Conference Infrastructure Systems, Chennai, India.

Hartmann, A.; Roehrich, J.K.; Frederiksen, L. & Davies, A. (2014). Procuring complex performance: The transition process in public infrastructure. International Journal of Operations & Production Management, Vol. 32 No. 2, pp. 174-194.

Holt, G. D., Olomolaiye, P. O., & Harris, F. C. (1994). Evaluating prequalification criteria in contractor selection. Building and Environment, 29(4), 437-448.

Hyman, W. A. (2009). Performance-Based Contracting for Maintenance. NCHRP Synthesis 389, Transportation Research Board, National Cooperative Highway Research Program Synthesis Program.

ISO 55000 (2014). Asset management: Overview, principles and terminology. International Standards Organization, Geneva, Switzerland.

Johnson, J.L., Sohi, R.S. & Grewal, R. (2004). The role of relational knowledge stores in interfirm partnering. Journal of Marketing, Vol. 68 No. 3, pp. 21-36.

Katzy, B.R. & Crowston, K. (2008). Competency rallying for technical innovation – the case of the Virtuelle Fabrik. Technovation, Vol. 28, pp. 679-692.

Lyons, B. & Mehta, J. (1997). Contracts, opportunism and trust: self-interest and social orientation. Cambridge Journal of Economics, Vol. 21 No. 2, pp. 239-257.

Mayer, K.J. & Argyres, N.S. (2004). Learning to contract: evidence from the personal computer industry. Organization Science, Vol. 15 No. 4, pp. 394-410.

Menches, C. L., Khwaja, N., & Chen, J. (2010). Synthesis of innovative contracting strategies used for routine and preventive maintenance contracts (No. 0-6388-P1). Center for Transportation Research, University of Texas at Austin.

Mitropoulos, P., & Howell, G. (2001). Model for understanding, preventing, and resolving project disputes. Journal of construction engineering and management, 127(3), 223-231.

Otto, S., & Ariaratnam, S. T. (1999). Guidelines for developing performance measures in highway maintenance operations. Journal of transportation engineering, 125(1), 46-54.

Ozbek, M. E., & de la Garza, J. M. (2011). Comprehensive Evaluation of Virginia Department of Transportation's Experience with its First Performance-Based Road-Maintenance Contract. Journal of Transportation Engineering, 137(12), 845-854.

Ozbek, M., de la Garza, J., & Piñero, J. (2010). Implementation of level-of-service component for performance-based road maintenance contracts. Transportation Research Record: Journal of the Transportation Research Board, (2150), 1-9.

Pakkala, P. (2002). Innovative project delivery methods for infrastructure. Finnish Road Enterprise, Helsinki, 19.

Parkman, C. C. (1998). Transferring road maintenance to the private sector: preliminary literature review and proposed study area for the project. London: British Transport Research Laboratory/DFID.

PIARC (2003). Procurement of goods, works and services by road administrations. PIARC Technical Committee on Performance of Road Administrations (C15).

Roehrich, J.K. & Caldwell, N.D. (2012.) Delivering integrated solutions in the public sector: The unbundling paradox. Industrial Marketing Management, Vol. 41 No. 6, pp. 995-1007.

Roehrich, J.K. & Lewis, M.A. (2014). Procuring complex performance: Implications for exchange governance complexity. International Journal of Operations & Production Management, Vol. 32 No. 2, pp. 221-241.

Segal, G.F., Moore, A.T., & McCarthy, S. (2003) Contracting for road and highway

maintenance. Reason Public Policy Institute, Los Angeles, CA.

Wallis, I., Bray, D., & Webster, H. (2010). To competitively tender or to negotiate–Weighing up the choices in a mature market. Research in Transportation Economics, 29(1), 89-98.

Yasamis, F., Arditi, D., & Mohammadi, J. (2002). Assessing contractor quality performance. Construction Management & Economics, 20(3), 211-223.